(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 392 693 A2

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 90303216.7

(22) Date of filing: 27.03.90

(51) Int. Cl.[5]: G01N 21/86, G01N 33/34, G01N 21/89

A request for correction of numbering of claims 1 - 10 on pages 15-17 of the specifications has been filed pursuant to Rule 88 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 2.2).

(30) Priority: 13.04.89 US 337659

(43) Date of publication of application: 17.10.90 Bulletin 90/42

(84) Designated Contracting States: AT BE CH DE DK ES FR GB IT LI LU NL SE

(71) Applicant: MACMILLAN BLOEDEL LIMITED
1075 West Georgia Street
Vancouver British Columbia V6E 3R9(CA)

(72) Inventor: Houston, Kevin Clifford Douglas
Suite 204 - 215-10th Street, New Westminster
British Columbia, Canada V3M 2Y1(CA)
Inventor: Popil, Roman Ewhen
13032-20th Avenue
White Rock, British Columbia, V4A 1Y9(CA)

(74) Representative: Heath, Derek James et al
BROMHEAD & CO. 19 Buckingham Street
London WC2N 6EF(GB)

(54) On-line texture sensing.

(57) The texture of a travelling web is determined by instantaneously illuminating an area of the web via a strobe light and photographing the illuminated area by a video camera correlated to operate in conjunction with the strobe. The signal from the camera is digitized, histogrammed and analyzed to determine the characteristics of the web. The strobe light may direct the light through the web or at an angle to the web and the video camera depending on the characteristics to be determined may be positioned to receive specularly reflected light from the web or reflected light or positioned on the opposite side of the web to receive light transmitted through the web. In one embodiment the light is polarized and directed at Brewster's angle onto the surface of the web and only similarly polarized specularly reflected light is received by the camera.

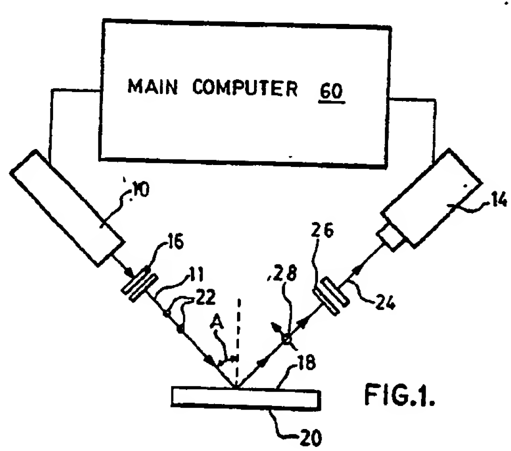

FIG.1.

EP 0 392 693 A2

$$\% \text{ dirt} = \sum_{i=0}^{i=\text{threshold}} (f_i) \times \left(\frac{100}{\text{Total \# of pixels}} \right) \quad (4)$$

where i = intensity

f_i = no. of pixels with intensity i

In this manner all of the pixels having an intensity below a preselected threshold level are counted as dirt particles based on the following:

The threshold for counting dirt is set at any preselected level but preferably will be a fixed fraction of the mean intensity level, for example threshold may be equal to the mean value of the histogram multiplied by a very small number that may be set by inspection of the segmented binary image to correspond with dirt specks on a pulp sheet.

The system may then be used to accept or reject depending on (a) the total area occupied by dirt particles or (b) the inclusion of significant large areas of a single dirt spot or any other suitable criteria that can be distinguished.

This technique may also be used with the strobe on the opposite side of the paper to the camera, i.e. strobe 100, only if the web transmits sufficient light.

It is also possible to detect plastic speck contaminants by substituting a source of infra red light for the strobe light and using the same analysis technique to determine the degree and location of plastic elements.

Blackening Sensor

The blackening sensor uses essentially the same configuration and hardware as the formation sensor. To simplify the operation and accommodate differences in color light intensity and basis weight, the gain factor F as determined by formula (2) is employed in this case to modify the selected blackening threshold (B_s)to correspond with an operating blackening threshold (B)

$$B \text{ (operating threshold)} = B_S \left(\frac{\text{selected blackening threshold}}{F \text{ (factor)}} \right) \quad (5)$$

and percent blackening is given by the formula

$$\% \text{ blackening} = \sum_{i=B}^{i=255} (f_i) \times \frac{100}{\text{Total \# of pixels}} \quad (6)$$

where f_i is the number of pixels having an intensity of i and i = intensity.

Obviously the higher the % blackening, the poorer the paper quality.

All of the described embodiments are suitable for on-line sensing of selected parameters and may be coupled with other equipment for example on a paper machine to aid in control.

The preferred embodiments of the invention are illustrated by way of examples given herein above and it is to be understood that the descriptions and drawings are for the purposes of illustration and as an aid to understanding and not intended as a definition of the limits of the invention.

Modifications will be evident to those skilled in the art without department from the spirit of the invention as defined in the appended claims.

Claims

Field of the Invention

The present Invention relates to web texture sensing. More particularly the present relates to texture sensors applying image analysis to instantaneous image signals generated by a video camera operated in synchronization with a strobe light.

Background to the Invention

Many different instruments have been designed for on-line sensing of web characteristics. Such equipment particularly related to paper includes on-line sensors for paper formation, fibre orientation, wire mark, etc.

One of the earlier developments for detecting formation is described in a paper "A Formation Tester Which Graphically Records Paper Structure" by Burkhard et al published in the Pulp and Paper Magazine of Canada, 60, No. 6, T319-T334 (June 1960) wherein it was emphasized that direction was an important factor that had to be considered in an instrument for measuring paper structure. This device utilizes an illuminator and a photo electric cell to sense the amount of light transmitted through the web and generates a transmitted light signal which is analyzed in a frequency spectrum analyzer. The light source and photo electric cell move axially of a cylinder on which the paper sample is mounted.

A more recent system is described in an article entitled 'Development of an On-line Formation Tester to Determine Optimal Use of Retention Aids' by Landmark et al published in the Paper Trade Journal, September 1984, pages 84 to 86. This system is based on the use of tester incorporating a laser and that was developed by the Norwegian Pulp and Paper Institute to measure the variations in basis weight. In particular for the instrument described by Landmark et al a specific laser was selected and illuminated a spot about one millimeter in diameter by directing light through the web, the light transmitted through the web was then projected onto a photo cell.

In U.S. Patent 4,648,712 issued March 10, 1987 to Bernholt a light source illuminates one side of the web and the radiation passing through the web is detected by a pair of detectors having fields of view along narrow strips which are perpendicular to each other. The detector outputs are processed to provide fibre orientation ratio, formation and basis weight measurements.

U.S. Patent 4,760,271 issued July 26, 1988 to Bernholt describes a system, which like the above described Bernholt system, illuminates paper from one side and provides optical means on the opposite side for detecting the light transmitted through the paper. A second illuminator is provided on the same side of the paper as the detector and directs light onto the paper at an oblique angle to a line normal to the plane of the paper web and the reflected light emanating from the second source is also detected.

U.S. Patent, 4,644,174 issued February 17, 1987 to Ouellette et al also describes directing a beam through the paper and utilizes a photo detector receiving the light transmitted through the paper in combination with a tuneable filter and a demodulator to produce a DC output reflecting size and distribution of fibers or flocs.

It is also known to measure the surface properties of paper by optical measurements. A recent technique for such optical measurement is described in a paper entitled 'Optical Measurement Throws New Light on Paper Surface' by Hansuebasl and Morantz published in Paper Technology in Industry, August 1987. This technique employs a scanning goniometer which varies the angle of incidence of impingement of a polarized light and studies the angular reflectance and attempts to correlate printability with surface non-uniformity as determined by the equipment.

Equipment has also been proposed for surface inspection for defects wherein the entire surface web is scanned to detect defects or faults in the paper and enhanced graphics are used to visually display a defect such as a small tear or the like in the paper. Such a device described in a paper entitled 'Solid State Surface Inspection Equipment' by P.W. Loose published in June, 1987 Tappi Journal, pages 69 to 74. This system uses a line scan camera having a charged coupled device (CCD) and an electronic exposure control. The amount of light applied to the CCD of the camera is regulated and the basic scanning rate of the camera is synchronized with the web speed.

An on-line dirt counting systems is described in an article by Kemeny et al. entitled 'On-line Automatic Pulp Dirt Count Measurement' Tappi Conference proceedings, 1987, pages 21-24 inclusive. The particular dirt counter described in this publication utilizes the CCD camera focused onto an illuminated surface of the pulp so that the light saturates the scanned segment of the pulp surface to eliminate any shadows which may tend to appear due to the roughness of the pulp surface. This device determines the dirt count by

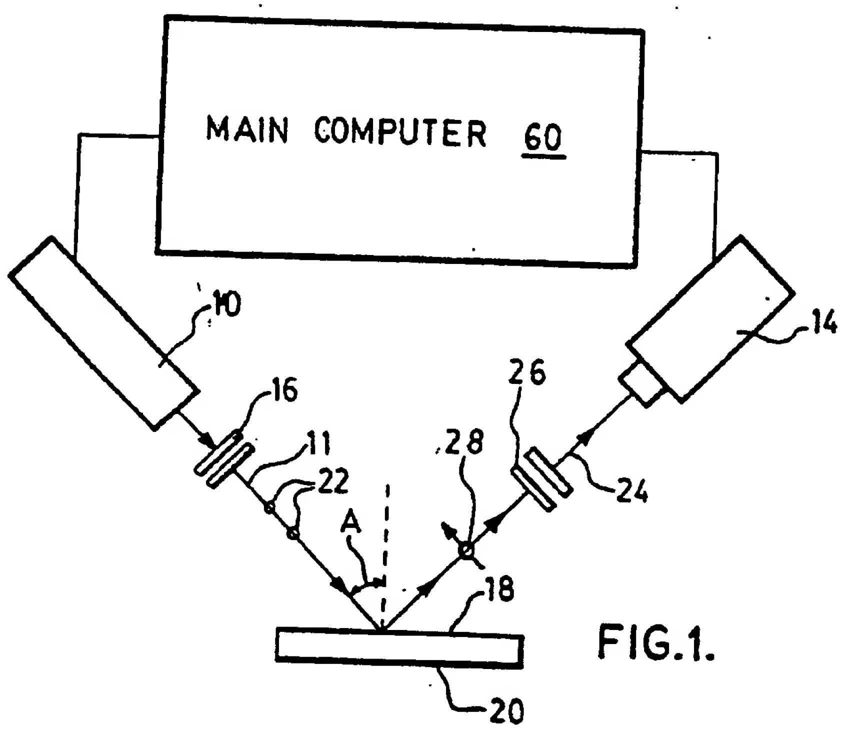

FIG.1.

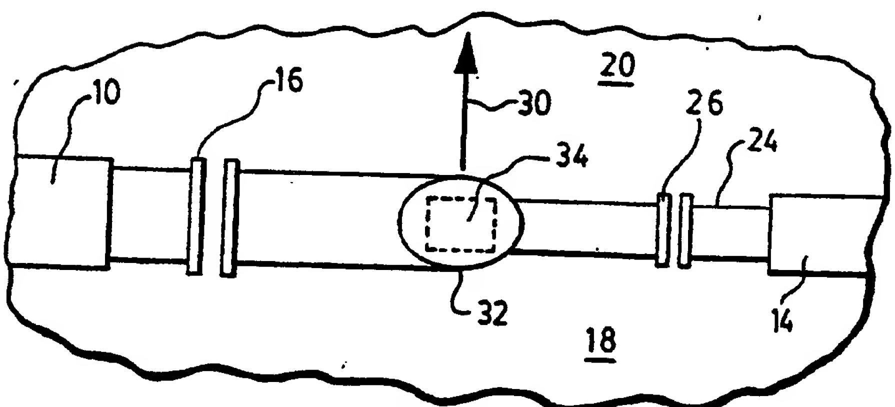

FIG.2.

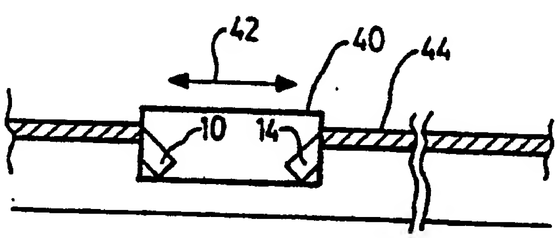

FIG.3.